

REMARKS/ARGUMENTS

Claims 1-21 are pending in this application, with claim 1 being an independent claim and all remaining claims ultimately depending from claim 1. Claims 4, 8-11 and 13-14 are amended to replace the terms "positive electrode" and "positive and/or negative electrode" with the terms "cathode" and "cathode and/or anode". Support for this amendment can be found in claim 1 and throughout the specification. This amendment makes the use of the terms consistent throughout the claims.

Claim 8 is also amended to delete the additional narrow range of "2.0 to 8.0 nm". This range is added in new dependent claim 22. Claim 9 is amended to delete the additional narrow range of " 1×10^{12} to 1×10^{13} pores per cm^2 ", which is added in new dependent claim 23. Claim 10 is amended to delete the additional narrow ranges of "within 10%" and "within 5%" of the average pore diameter. These ranges are added in new dependent claims 24 and 25.

The Abstract is amended to incorporate additional description of the invention. Support for this amendment can be found on page 1, lines 5-10, of the application as filed.

It is believed no new matter is added by these amendments.

Objections to the specification

The Examiner objected to the abstract of the disclosure because the abstract was of insufficient length. The Abstract is amended herein to fall within 50 and 150 words. As amended, it is believed the Abstract sufficiently describes the invention and satisfies the requirements of MPEP 608.01(b). Accordingly, it is believed that this objection can be withdrawn.

Rejections under 35 USC 112

The Examiner rejected claims 8-14 under 35 U.S.C. 112, second paragraph, as being indefinite.

With regard to claims 8-10, the Examiner noted that these claims contain a broad range (such as a pore diameter within the range from 1 to 10 nm) as well as an additional narrow range (such as a pore diameter within the range from 2.0 to 8.0 nm). Therefore, the Examiner asserted that it was unclear whether the broad range or narrow range was intended to be claimed. As amended herein, the additional narrower ranges are deleted from claims 8-10 and are introduced in separate dependent claims 22-25. None of the amended claims contain a broad range as well as an additional narrower range. Accordingly, it is believed that this rejection can be withdrawn.

With regard to claims 8-14, the Examiner noted that claim 1 and other claims use the terms "anode" and "cathode" while claims 8-11 and 13-14 use the term "positive and/or negative electrode". Claims 4, 8-11 and 13-14 are amended herein to replace the terms "positive electrode" and "positive and/or negative electrode" with the terms "cathode" and "cathode and/or anode". As amended, it is believed that the terms are now consistent throughout the claims and that the terms in the dependent claims have proper antecedent basis. Accordingly, it is believed that this rejection can also be withdrawn.

Rejections under 35 USC 103

A. The Examiner rejected claims 1-16 and 19-21 under 35 U.S.C. 103(a) as being obvious over Sugnaux (U.S. Published Application 2004/0131934) in view of Anderson (U.S. Patent 5,963,417). Applicants respectfully traverse.

Claim 1 of the present application is directed toward an electrochemical cell having a cathode, an anode and an electrolyte, where the anode comprises titanium dioxide or a lithium titanate; and the electrolyte comprises an aqueous solution

containing lithium and hydroxide ions. The remaining claims ultimately depend from claim 1 and include claims stating that the anode and/or cathode are mesoporous and reciting the physical properties of the mesoporous material.

Sugnaux discloses a high kinetics rate electrochemical cell comprising a cathode, an anode and a non-aqueous electrolyte solution containing lithium. The Examiner noted that Sugnaux fails to disclose an aqueous electrolyte as required by the claims and turns to Anderson to overcome this deficiency. Anderson discloses an electrochemical cell comprising a cathode, an anode and an aqueous electrolyte containing lithium and hydroxide ions. The Examiner concluded that it would have been obvious to one ordinarily skilled in the art to substitute the non-aqueous electrolyte of Sugnaux with the aqueous electrolyte of Anderson to arrive at the presently claimed invention because such a combination is a mere substitution requiring only routine skill in the art. Applicants respectfully disagree.

To establish a prima facie case of obviousness, there must be a reasonable expectation of success with some degree of predictability. See MPEP 2143.02. Combining known elements in the prior art is not sufficient to render the claim obvious unless the combination would have yielded nothing more than predictable results to one of ordinary skill in the art. See MPEP 2143 and KSR International Co. v. Teleflex Inc., 550 U.S. 398, 82 USPQ2d 1385, 1395 (2007). Applicants assert that one skilled in the art would not have had a reasonable expectation that the combination of references cited by the Examiner would have successfully resulted in the present claims. If anything, Applicants believe that these references actually teach away from the combination suggested by the Examiner.

As is known to those skilled in the art, the electrolyte is not a minor component of an electrochemical cell. Manufacture of a viable device requires careful matching of electrode and electrolyte types. In particular, care must be taken to ensure that the electrolyte is stable over the potential (voltage) range through which the positive and

negative electrodes operate. Poorly matched electrode/electrolyte couples can result in breakdown (electrolysis) of the electrolyte and significantly decreased device performance and lifetime.

As stated on page 1, lines 15-24, of the specification, titanium dioxide is a well known negative electrode for lithium-ion batteries in which it is combined with a highly oxidizing positive electrode. The specification further explains that a non-aqueous electrolyte is normally used in such devices because it is believed the potential (voltage) for lithium insertion into a TiO_2 negative electrode is outside the physical stability of water, and that the generation of hydrogen would occur before the lithium ion insertion. Anderson (cited by the Examiner) similarly states that "aqueous electrolytes can only sustain up to about 1-2 V of potential before electrochemical decomposition of water occurs" (column 10, lines 7-9). Accordingly, one skilled in the art would not expect that aqueous electrolytes could be used in any electrochemical cell. On the contrary, one skilled in the art would recognize that the substitution of a non-aqueous electrolyte by an aqueous electrolyte could potentially result in the breakdown of the electrolyte and complete failure of the device.

The selection of an appropriate electrolyte for a particular electrode type is therefore not routine, and it is certainly not correct to suggest that electrolyte types can simply be interchanged between different electrode systems. This is particularly true when moving from a non-aqueous electrolyte to an aqueous electrolyte system as the present invention requires. The fact that the potential range over which aqueous electrolytes are stable is much narrower than that for non-aqueous electrolytes means that many electrode materials able to be reliably used in non-aqueous systems are not suitable for use in aqueous systems as their operating potential lies outside the window of stability of the aqueous system and will therefore cause breakdown of the electrolyte.

Sugnaux is directed toward electrodes for high power lithium ion insertion batteries, photovoltaic cells, supercapacitors and fast electrochromic devices

(paragraphs [0004] and [0060]). Sugnaux further discloses that only non-aqueous electrolytes are used and that the electrolyte is an aprotic solvent or liquid salt (paragraphs [0001], [0087] and Example 9). Given the teaching of Sugnaux that non-aqueous electrolytes should be used, and the physical instability of water as an electrolyte in such devices, one skilled in the art would have no expectation that the substitution of an aqueous electrolyte into the electrochemical cell of Sugnaux would result in a working device. In fact, one skilled in the art would believe that such a substitution could result in the breakdown of the electrolyte and could be fatal to the device. In addition, the explicit disclosure of only non-aqueous electrolytes by Sugnaux would, if anything, teach one skilled in the art away from the use of aqueous electrolytes.

Anderson does not provide any teaching or suggestion that indicates aqueous electrolytes could avoid electrochemical decomposition and breakdown in devices utilizing titania or lithium titanate electrodes such as disclosed in Sugnaux or the present claims. Anderson discloses a wide range of metal oxides as possible electrode active materials (see Claims 2 and 3), and also discloses a wide range of possible electrolytes, including both non-aqueous and aqueous electrolytes (see Column 10). However, despite the broad disclosure, the working examples disclosed by Anderson relate only to nickel oxides, both with aqueous and non-aqueous electrolytes. Anderson does not provide any examples using titania or lithium titanate, much less any examples combining titania or lithium titanate with aqueous electrolytes. Additionally, Anderson explicitly states that the "non-aqueous electrolyte systems display completely different results" than aqueous electrolyte systems (column 16, lines 50-54). Accordingly, one skilled in the art would not have any reason to expect an electrochemical cell having a non-aqueous electrolyte to behave similarly if an aqueous electrolyte was substituted for the non-aqueous electrolyte.

Furthermore, Anderson also states that the low conductivity of titanium oxide makes it less attractive compared to other oxides (column 7, lines 44-47). Anderson

also states that the performance of titanium oxides could be improved by employing “lithium intercalation and organic electrolytes” (emphasis added)(column 7, lines 47-54). Thus, although Anderson discloses lots of metal oxide electrode materials and lots of possible electrolytes, the specific teaching of Anderson discourages the use of titanium compounds unless an organic electrolyte is used. Not only does Anderson fail to provide a reason or suggestion to substitute the non-aqueous electrolytes of Sugnaux with aqueous electrolytes, but it is believed the disclosure of Anderson actually teaches away from such a substitution.

For these reasons presented above, Applicants respectfully believe that one skilled in the art would not have had a reasonable expectation that the combination of the aqueous electrolyte of Anderson with the electrochemical cell of Sugnaux would have resulted in a successful device as recited by present claim 1. Therefore, it is believed that this rejection should be withdrawn. Because claims 2-16 and 19-21 ultimately depend from claim 1, it is requested that these rejections also be withdrawn.

B. The Examiner also rejected claims 1 and 17-21 under 35 U.S.C. 103(a) as being obvious over Zaghib (U.S. Published Application 2004/00202934) in view of Anderson. Applicants respectfully traverse.

Zaghib discloses an electrochemical cell comprising a cathode, an anode and a non-aqueous electrolyte comprising lithium, where the anode comprises titanium oxide or lithium titanate. The Examiner asserted that it would have been obvious to one skilled in the art to substitute the non-aqueous electrolyte of Zaghib with the aqueous electrolyte disclosed in Anderson because such a combination is a mere substitution requiring only routine skill in the art. Applicants respectfully disagree.

As discussed above, the selection of an appropriate electrolyte for a particular electrochemical device is not routine and requires careful matching of electrode and electrolyte types. Care must be taken to ensure that the electrolyte is stable over the

potential range through which the positive and negative electrodes operate. This is particularly true with aqueous and non-aqueous electrolyte systems because aqueous electrolytes are stable at a much narrower potential (voltage) range. Accordingly, one skilled in the art would not expect that aqueous electrolytes could be routinely substituted and used in any electrochemical cell. On the contrary, one skilled in the art would recognize that the substitution of a non-aqueous electrolyte with an aqueous electrolyte could potentially result in the breakdown of the electrolyte and complete failure of the device.

Zaghib only discloses and exemplifies the use of non-aqueous electrolytes. Given the teaching of Zaghib that non-aqueous electrolytes should be used, and the physical instability of water as an electrolyte in electrochemical devices, one skilled in the art would have no expectation that the substitution of an aqueous electrolyte in the electrochemical cell of Zaghib would still result in a working device. Furthermore, Anderson discloses that "non-aqueous electrolyte systems display completely different results" than aqueous electrolyte systems (column 16, lines 50-54), strongly suggesting that if the non-aqueous electrolytes of Zaghib were substituted with aqueous electrolytes, the electrochemical cells would behave very differently. In addition, Anderson discourages the use of titanium oxide due to its low conductivity unless its performance is improved by employing "lithium intercalation and organic electrolytes" (emphasis added)(column 7, lines 44-54).

Accordingly, there is no teaching in Zaghib or Anderson that would lead one skilled in the art to reasonably expect that the substitution of the aqueous electrolytes of Anderson for the non-aqueous electrolytes of Zaghib would successfully arrive at the presently claimed invention. Therefore, it is requested that this rejection also be withdrawn.

C. The Examiner also rejected claims 1, 4-10, 13, 19 and 21 under 35 U.S.C. 103(a) as being obvious over Bekesh (RU 2170467C1) in view of Anderson. Applicants respectfully traverse.

Bekesh discloses adding titanium oxide as an additive for electrodes of capacitors. The Examiner asserted that it would have been obvious to add titanium oxide as taught by Bekesh to the electrodes of Anderson to arrive at the presently claimed invention. Applicants respectfully disagree.

Bekesh merely discloses that metal oxides, such as titanium oxide, can be added to the electrodes of capacitors to reduce internal resistance. However, there is no disclosure in Bekesh as to what kind of capacitor devices could be treated with this additive. For example, there is no disclosure teaching or suggesting that this additive would be suitable for use in capacitors having a liquid electrolyte, particularly an aqueous electrolyte. Furthermore, as discussed above, Anderson discourages the use of titanium oxide due to its low conductivity unless its performance is improved by employing "lithium intercalation and organic electrolytes" (emphasis added)(column 7, lines 44-54). Thus, the only disclosure in either Bekesh or Anderson which speaks to a possible combination teaches away from the present invention and suggests the use of a non-aqueous electrolyte as opposed to an aqueous electrolyte.

Accordingly, one skilled in the art would have no expectation that the combination of the additive of Bekesh and the capacitor of Anderson could successfully arrive at the presently claimed invention. Therefore, it is requested that this rejection also be withdrawn.

Conclusion

In view of the foregoing, it is submitted that this case is in condition for allowance, and passage to issuance is respectfully requested. If there are further issues related to

patentability, the courtesy of a telephone interview is requested, and the Examiner is invited to call to arrange a mutually convenient time.

It is believed that this submission does not require the payment of any fees. However, if this is incorrect, please charge any deficiency to Deposit Account No. 07-1969.

Respectfully submitted,
/michaelcurtis/

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